Cambridge International Examinations
Cambridge International Advanced Subsidiary Level

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

0955108918

PHYSICAL SCIENCE **8780/04**

Paper 4 Advanced Practical Skills **October/November 2015**

1 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Give details of the practical session and laboratory, where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **both** questions.
You will be allowed to work with the apparatus for a maximum of 45 minutes for each question.
Electronic calculators may be used.
You are advised to show all working in calculations.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 11 and 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Session
Laboratory

For Examiner's Use	
1	
2	
Total	

This document consists of **11** printed pages and **1** blank page.

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CAMBRIDGE International Examinations

[Turn over

1 When a marble is dropped into sand it makes a crater in the sand. In this experiment you will measure the diameter of the craters made when a marble is dropped from known heights into sand.

(a) Measure and record the diameter *d* of the marble.

d = ... cm [1]

(b) The apparatus shown in Fig. 1.1 is set up for you. **Do not alter or adjust this apparatus**.

You are also given a 30 cm ruler, a set square and some additional sand to top up the tray if necessary. Use the 30 cm ruler to level the sand between each set of readings.

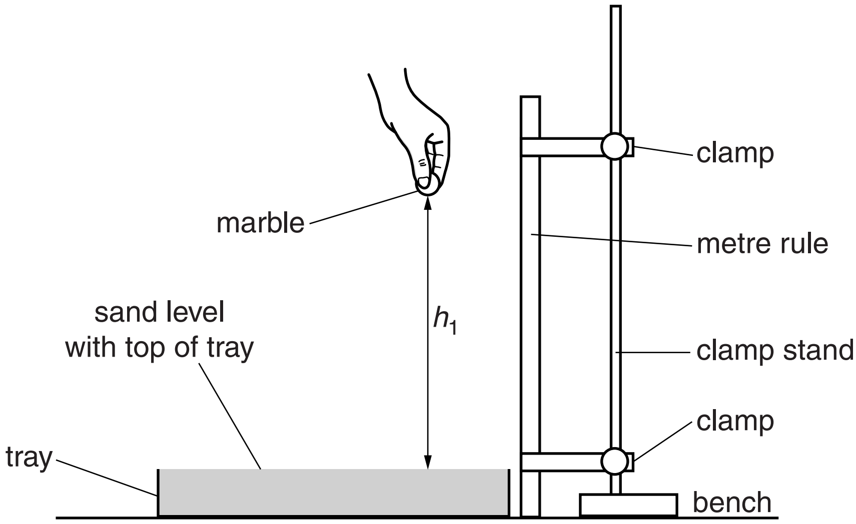

Fig. 1.1

(i) Hold the marble above the sand so that the bottom of the marble is approximately level with the 65 cm mark on the metre rule.

Record the height h_1, the distance from the bottom of the marble to the sand. Record all the measurements taken to show how you determined h_1.

h_1 = ... [1]

(ii) Drop the marble into the sand. The sand will have a profile similar to that shown in Fig. 1.2.

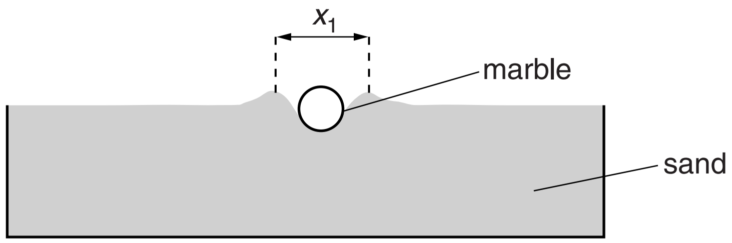

Fig. 1.2

(iii) Measure and record the diameter x_1 of the crater.

x_1 = ... cm

(iv) Carefully remove the marble and use the 30 cm ruler to level the sand with the top edge of the tray.

(v) Drop the marble from the same height h_1 twice more and find the average diameter of the crater x_{AV1} using **all three** readings. Record **all** your results and show your working.

x_{AV1} =........................... cm [1]

(vi) Subtract the diameter of the marble d from the average diameter of the crater x_{AV1}. This quantity is y_1, where $y_1 = x_{AV1} - d$.

y_1 = ... cm

(c) Repeat the steps in **(b)**, dropping the marble from height h_2, where h_2 is between 25 cm and 35 cm.

h_2 = ... cm

x_{AV2} = ... cm

y_2 = ... cm [2]

(d) Describe the steps you took to ensure that your readings for *h* and *x* were as accurate as possible.

(i) height *h*

....

....

....

.... [1]

(ii) diameter of the crater *x*

....

....

....

.... [1]

(e) Table 1.1 shows the uncertainties in some of the quantities measured.

Table 1.1

	diameter of marble d / cm	height h / cm	diameter of crater x / cm	$y = (x - d)$ / cm
uncertainty	± 0.1		± 0.2	

(i) Estimate the uncertainty in measuring height *h*.
Record your estimate in Table 1.1. [1]

(ii) Calculate the uncertainty in *y*.
Record your answer in Table 1.1. [1]

(iii) Calculate the percentage uncertainty in *y*.

percentage uncertainty in y = ...% [1]

(f) It is suggested that $y^2 = Kh$, where K is a constant.

Use the uncertainties in Table 1.1 to show whether or not your results support this suggestion.

....

.... [4]

(g) Describe how you would verify that y^2 is proportional to h.

....

....

.... [1]

[Total: 15]

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2 You are to investigate the energy change when 2.00 mol dm^{-3} sodium hydroxide is reacted with dilute sulfuric acid. The experiment you will perform is known as a thermometric titration.

(a) Place a polystyrene cup into the 250 cm^3 beaker to prevent it from falling over.

(i) Use the pipette and pipette filler to transfer 25.0 cm^3 of sodium hydroxide solution into the polystyrene cup. Stir the solution with the thermometer. Measure and record the temperature *T* of the solution.

T .... °C

(ii) You will be adding portions of sulfuric acid to the sodium hydroxide solution.

Construct a table to record 12 sets of readings of the **total** volume of acid V_T added and the temperature *T* of the solution.

Record the information from **(a)(i)** in your table.

[3]

(iii) Fill the burette with dilute sulfuric acid.

(iv) Add about 4 cm^3 of the acid to the sodium hydroxide solution. Stir thoroughly with the thermometer and measure the temperature.

Record in your table, to an appropriate level of precision, the total volume of acid added and the temperature.

(v) Add a further **ten** portions of sulfuric acid until a total of about 44 cm^3 has been added.

Measure the temperature of the solution after each addition.

Record all the readings in your table to an appropriate level of precision.

(b) **(i)** Plot a graph of temperature T (y-axis) against the total volume of sulfuric acid added V_T (x-axis) on the grid provided.

Use the points you have plotted to draw **two** best-fit curves.

Draw a best-fit curve for the points as the temperature rises.
Draw a second best-fit curve for the points as the temperature falls.

Extend the curves until they cross each other. The point where the curves cross is the neutral point of the titration. [3]

(ii) Use your graph to determine

1. the volume of sulfuric acid V_N needed to exactly neutralise 25.0 cm^3 of the sodium hydroxide solution,

V_N = ... cm^3 [1]

2. the temperature rise ΔT caused by the reaction.

ΔT = ... °C [1]

(iii) Use your answer to **(b)(ii)1** to calculate the concentration of the sulfuric acid.

concentration of sulfuric acid .... $mol\,dm^{-3}$ [1]

(c) The enthalpy change for the reaction shown below is known as the enthalpy change of neutralisation ΔH_N.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

ΔH_N is the enthalpy change when one mole of hydroxide ions, OH^-, exactly neutralises one mole of H^+ ions.

Question 2 continues on the next page

(i) Use the formula below to calculate the thermal energy change q for your thermometric titration.

$$q = mc\Delta T$$

Assume that the density of the reaction mixture is 1.00 $g\,cm^{-3}$ and that its specific heat capacity c is 4.18 $J\,g^{-1}\,°C^{-1}$.

q = ... J [2]

(ii) Use your answers to **(b)(iii)** and **(c)(i)** to calculate a value for the energy change of neutralisation, ΔH_N.

ΔH_N .... $kJ\,mol^{-1}$ [2]

(d) **(i)** Suggest the main source of error in your thermometric titration experiment.

....

....

(ii) Suggest what effect the main source of error would have on ΔT.

....

....

....

(iii) Suggest what effect the main source of error would have on ΔH_N.

....

....

....

[2]

[Total: 15]

Qualitative Analysis Notes

Key: [ppt. = precipitate]

1 Reactions of aqueous cations

	reaction with	
	$NaOH(aq)$	$NH_3(aq)$
aluminium, $Al^{3+}(aq)$	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, $NH_4^+(aq)$	no ppt. ammonia produced on heating	–
barium, $Ba^{2+}(aq)$	no ppt. (if reagents are pure)	no ppt.
calcium, $Ca^{2+}(aq)$	white ppt. with high $[Ca^{2+}(aq)]$	no ppt.
chromium(III), $Cr^{3+}(aq)$	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), $Cu^{2+}(aq)$	pale blue ppt. insoluble in excess	blue ppt. soluble in excess giving dark blue solution
iron(II), $Fe^{2+}(aq)$	green ppt. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air insoluble in excess
iron(III), $Fe^{3+}(aq)$	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, $Mg^{2+}(aq)$	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), $Mn^{2+}(aq)$	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc, $Zn^{2+}(aq)$	white ppt. soluble in excess	white ppt. soluble in excess

2 Reactions of anions

ion	*reaction*
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, Cl^- (aq)	gives white ppt. with Ag^+(aq) (soluble in NH_3(aq))
bromide, Br^- (aq)	gives pale cream ppt. with Ag^+(aq) (partially soluble in NH_3(aq))
iodide, I^- (aq)	gives yellow ppt. with Ag^+(aq) (insoluble in NH_3(aq))
nitrate, NO_3^- (aq)	NH_3 liberated on heating with OH^-(aq) and Al foil
nitrite, NO_2^- (aq)	NH_3 liberated on heating with OH^-(aq) and Al foil, NO liberated by dilute acids (colourless NO $\rightarrow$ (pale) brown NO_2 in air)
sulfate, SO_4^{2-} (aq)	gives white ppt. with Ba^{2+}(aq) or with Pb^{2+} (insoluble in excess dilute strong acid)
sulfite, SO_3^{2-} (aq)	SO_2 liberated with dilute acids, gives white ppt. with Ba^{2+}(aq) (soluble in excess dilute strong acid)

3 Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	"pops" with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless